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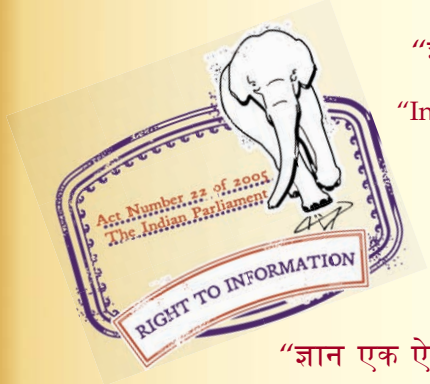
IS 10241-2 (1982): Electrical cables for aircraft, Part 2: Pren type electric cables [TED 14: Aircraft and Space Vehicles]



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IS : 10241 (Part II) - 1982
(Reaffirmed 2005)

Indian Standard

SPECIFICATION FOR ELECTRICAL CABLES FOR AIRCRAFT

PART II PREN TYPE ELECTRIC CABLES

UDC 621·315·2 : 629·13·066

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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September 1983

Indian Standard

SPECIFICATION FOR ELECTRICAL CABLES FOR AIRCRAFT

PART II PREN TYPE ELECTRIC CABLES

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Indian Standard

SPECIFICATION FOR ELECTRICAL CABLES FOR AIRCRAFT

PART II PREN TYPE ELECTRIC CABLES

0. FOREWORD

0.1 This Indian Standard (Part II) was adopted by the Indian Standards Institution on 24 December 1982, after the draft finalized by the Aircraft Electrical Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 The general requirements and tests for electrical cables for aircraft are covered in Part I of this standard. This standard (Part II) specifies the particular requirements and tests for pren type cables used for aircraft.

0.3 The aircraft industry is one of the potential users of cables and conductors. In view of the severity of conditions that have to be encountered by the various accessories that go into the making of an aircraft, it is necessary that they should be subject to a strict quality audit.

0.4 With a view to specify the various requirements that have to be satisfied by the cables to be used in aircraft and in order to standardize the type of cables to be used so that there could be substantial saving in material, this standard has been brought out.

0.5 In preparing this standard, considerable assistance has been derived from BS : 2E 21 Pren type electrical cables for aircraft, issued by the British Standards Institution.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part II) specifies the requirements and test for ' Pren ' type cables for aircraft wiring of circuits where the voltage between conductors, or between a conductor and metal braid or the aircraft structure

*Rules for rounding off numerical values (*revised*).

does not exceed 600 V rms and the frequency does not exceed 1 600 Hz. These cables are suitable for any combination of ambient temperature and conductor current for continuous service not producing a stabilized conductor temperature which exceeds 90°C. These cables are also suitable for fixed wiring in aircraft when low temperatures up to —75°C are encountered, but are not suitable for severe flexing below —40°C.

1.2 These cables do not support combustion.

1.3 These cables are not suitable for use without additional protection in areas where ester based fluids are present.

2. TERMINOLOGY

2.0 For the purposes of this standard, the following definitions, in addition to those given in Part I of this standard shall apply.

2.1 Pren Type — Cable with a copper conductor and an insulation of glass braid and polychloroprene compound, for single core cables. Multi-core cables have an overall finish of glass braid and lacquer.

2.2 Prenal Type — Similar to the pren range but with a conductor of aluminium instead of copper.

2.3 Prenmet Type — Similar to the pren range but with the addition of a metal braid.

2.4 Prensheath Type — Multi-core pren cables sheathed with a polychloroprene compound in place of the lacquered glass braid.

3. CLASSIFICATION

3.1 The cables shall be classified and identified by a series of numbers indicative of the current rating as given in Appendix A.

4. MATERIALS

4.0 The material shall comply with the requirements of 3 of IS : 10241 (Part I)-1982*. Should any deviation occur between the details of IS : 10241 (Part I)-1982* and those of this standard, the provisions of the latter shall apply.

4.1 Copper Conductors and Wires — Copper conductors and wires shall be in accordance with IS : 8130-1976† as far as applicable. Wires taken from conductors, but not from braids shall meet the requirements for maximum tensile strength and minimum elongation at break specified in **9.4.1.**

*Specification for electrical cables for aircraft: Part I General requirements and tests.

†Specification for conductors for insulated electric cables and flexible cords.

4.2 Aluminium Conductors — Aluminium wires shall be hard drawn and, before stranding, shall generally conform with the requirements of IS : 8130-1976*. Aluminium wires taken from the stranded or bunched conductor shall comply with the tensile and wrapping test requirements specified in **9.4.1**.

4.3 Glass Braid — The free alkali content of the glass shall not exceed one percent. The glass shall be of such fineness that the finished cable complies with all the test requirements of this standard.

4.4 Polychloroprene Compound — The polychloroprene compound shall be of such a quality that the finished cable complies with all the test requirements of this standard.

4.5 Lacquer — The lacquer shall consist of a non-inflammable, heat, oil and water resistant compound.

5. CONSTRUCTION

5.0 General

5.0.1 *Conductor* — The conductor shall be braided, bunched, stranded or rope stranded, as specified. It shall consist of tinned annealed copper wires complying with the requirements of **4.1** or of hard drawn aluminium wires complying with the requirements of **4.2**. Joints in the single copper wires shall be brazed or soldered but the complete conductor shall not be joined. In the case of aluminium and braided copper conductors the ends of the wires may be tucked into the conductor. The conductor of the uniflexpren cable shall be of a braided construction which shall not be on a string centre.

5.0.1.1 The number and diameter of individual wires and the formation to be used for the complete conductor shall be as specified in Tables 1 and 2.

5.0.2 *Insulation* — The insulation adjacent to the conductor shall consist of a glass braid. A polychloroprene compound, the colour of which shall be in accordance with **6**, shall be applied over the glass braid to the dimensions given in Tables 1 and 2. The insulation shall be of uniform circular cross-section throughout the length of the cable and the conductor shall be evenly centred in the insulation.

5.0.2.1 The insulation shall not be loose, but it shall be possible to strip the complete insulation, leaving the conductor in a condition sufficiently clean to permit satisfactory connection to terminations.

5.0.2.2 The radial thickness at any point in the wall of the polychloroprene compound shall be not less than the values given in Tables 1 and 2.

*Specification for aluminium conductors for insulated electric cables and flexible cords.

5.1 Unipren Cables — The cables shall consist of single cores complying with the requirements of **4.1, 4.3, 4.4** and **5.0**. The polychloroprene compound insulation shall be coloured and marked as required in **6**.

5.2 Multi-Core Cables — Multi-core cables shall be coloured as specified in **6** and Table 3. They shall be circular. Septopren large cable shall consist of seven cores laid up around a central dummy core.

5.2.1 The laid-up cores shall be covered with a glass braid coated with a non-inflammable, heat oil and water resistant lacquer, coloured in accordance with **6**.

5.2.2 If fillers are used to provide a good shape they shall be of polychloroprene compound supported, if desired, by a thin textile thread.

NOTE — It shall be possible to strip the glass braid and lacquer from the cores without damage to the latter.

5.2.3 The overall dimensions of the cables shall comply with the values given in Table 4.

5.3 Prenal Cables — The cables shall consist of single cores complying with the requirements of **4.2, 4.3, 4.4** and **5.0.1**. The polychloroprene compound shall be coloured and marked as specified in **6**.

5.4 Prenmet Cables — The cables shall consist of pren cables to which has been added a metal braid. Single-core cables shall consist of unipren type cable to which a metal braid has been applied. Multi-core cable shall be constructed by metal braiding a multi-core pren cable.

5.4.1 Tinned copper wires, as specified in **4.1** shall be used to form the overall metal braid. The braid shall be close fitting, but wherever the cable is cut it shall be possible to slide the metal braid back by hand to a distance of 100 mm in a length of 600 mm, one end of the cable being clamped. The braid shall subsequently be capable of being returned to within 25 mm of its original position.

5.4.2 Where breaks in the individual wires occur, the ends shall be soldered or tucked out of the braid and there shall be not more than one such break in any 25 mm length of cable.

5.4.3 Where renewal of spindles is necessary, the ends shall be tucked out of the braid, and there shall not be more than one spindle renewal in any 300 mm length of cable.

5.4.4 There shall be no joints in the complete braid.

5.4.5 The diameter of wire used shall be as specified in Tables 5 and 6. The number of spindles and ends per spindle shall be such as to ensure that the filling factor is not less than 0·70. The lay factor shall not exceed 3. The filling factor and lay factor shall be calculated as given in Appendix B.

5.5 Prensheath Cable — The cables shall consist of cores of the multi-pren range and shall be sheathed overall with a polychloroprene compound of the thickness specified in Table 7. The sheath shall be coloured as stated in 6 and shall not be loose but it shall be possible to remove it from the cores without damaging them.

5.5.1 If fillers are used to provide a good shade, they shall be of polychloroprene compound, supported, if desired, by a thin textile thread.

5.5.2 The overall dimensions of the cable shall be as specified in Table 7.

5.5.3 Prensheath cables shall be circular, and shall consist of appropriate cores coloured as specified in Table 3. Sextoprensheath and septoprensheath large cables shall consist of cores laid up around a central dummy core. Nonoprensheath cable shall consist of two cores twisted together with seven cores around them.

5.6 Fastness of Colours of Cables — All colours shall be fast to light and moisture. The materials used shall be capable of retaining their colours after storage for long periods in the tropics.

6. IDENTIFICATION OF CURRENT RATING

6.1 The nominal current rating of unipren cables up to and including 12 A size shall be indicated by colouring of the polychloroprene compound as follows:

Cable Type	*Size*	*Colour*
Uniflexpren	6A	Black
Unipren	4A	Red
Unipren	6A	Blue
Unipren	9A	Brown
Unipren	12A	Yellow

6.2 Unipren cables of 18A size and over shall have the polychloroprene compound coloured blue and the nominal current rating shall be indicated by numerals permanently and legibly printed. Preferably, the horizontal axis of the figures should be parallel to the axis of the cable (*see* Fig. 1). The printing, which shall be black, shall be repeated at intervals of not more than 150 mm. The height of the numerals shall be approximately two-thirds of the maximum overall diameter of the core for sizes up to and including 100 A and the size of numeral used for the 100 A cable shall be used for all cables above this size.

6.3 Uniprenal cables shall have the polychloroprene compound coloured yellow and the nominal current rating shall be indicated by numerals in the same way as for the unipren 18 and larger cables. In addition the letters 'AL' shall accompany the numeral, preferably as a suffix (*see* Fig. 1).

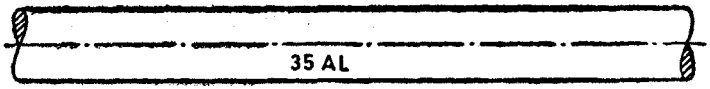

FIG. 1 IDENTIFICATION OF CURRENT RATING AND MATERIAL OF CONDUCTOR

6.4 Multi-pren, multi-prenmet and multi-prensheath cables shall have the lacquer or polychloroprene compound cover coloured as follows:

Cable Size	*Colour*
4A	Red
6A	Blue
9A	Brown
12A	Yellow
18A and over	Blue

6.5 The colours of the individual cores in multi-core cables shall be in accordance with Table 3, and the blue core in cables having sizes 18A and above shall be printed with the current rating as for unipren cables.

6.6 If desired by the cable manufacturer, one bobbin of coloured cotton or glass thread may be incorporated in the glass braid adjacent to the conductor to assist the cable manufacturer during the production of cores. The colour of this thread when used shall be red for 4A cores, blue for 6A cores, brown for 9A cores and yellow for 12A cores.

6.7 Where the polychloroprene compound is applied in more than one layer, the outer layer only need be coloured.

7. IDENTIFICATION OF MANUFACTURER AND YEAR OF MANUFACTURE

7.1 The manufacturer shall not mark the cable itself with his name and address, but a marker thread or threads of cotton or other material insoluble in acetone shall be used, the colours being in accordance with the Indian Standards Institution register of colours of manufacturers, identification threads for electric cables and cords.

7.2 An additional coloured marker thread or threads made of cellulose acetate, or other similar material readily soluble in acetone, shall be included for identification of the year of manufacture of the cable. This shall be taken as the year in which the vulcanizing of the insulation is commenced and the colours shall be as stated in Table 8.

7.3 The marker threads shall be placed between the conductor and the glass braid. They shall not be laid within the conductor.

8. PACKING AND MARKING

8.0 Provisions of 6 of IS : 10241 (Part I)-1982* shall apply.

8.1 Packing — Except for unflexpren cable, the length of cable, in one piece and on a separate coil, reel or drum shall be 100 m, or as agreed to between the manufacturer and purchaser.

8.1.1 For uniflexpren cable the minimum length of one piece shall be 25 m and there shall not be more than three lengths on any 100 m reel.

8.1.2 After testing, the cable shall have the ends sealed to prevent the ingress of moisture.

8.2 Marking — Each length shall bear a linen label giving the following particulars:

a) Name of manufacturer;
b) Nomenclature of cable (for example, Unipren 4);
c) Size of conductor (for example, 19/152);
d) The number of this standard, Ref IS : 10241 (Part II)-1982;
e) Date of manufacture (month and year);
f) Release reference number; and
g) Actual length in metres.

8.2.1 Each coil, drum or reel may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

9. TESTS

9.0 General

9.0.1 The provisions of 7.1 of IS : 10241 (Part I)-1982* shall apply.

9.1 Classification of Tests

9.1.1 *Type Tests* — The following shall constitute type tests:

a) Construction (*see* **9.2**);
b) Identification, packing and marking (*see* **9.3**);

*Specification for electrical cables for aircraft: Part 1 General requirements and tests.

c) Mechanical strength of conductors (*see* **9.4**);
d) Non-inflammability test (*see* **9.5**);
e) Tinning test (*see* **9.6**);
f) Resistance to fluids (*see* **9.7**);
g) Ageing in air (*see* **9.8**);
h) Low temperature test (*see* **9.9**);
j) Flexibility (*see* **9.10**);
k) Voltage test (*see* **9.11**);
m) Voltage test on core (*see* **9.12**);
n) Insulation resistance test on core (*see* **9.13**);
p) Spark test on core (*see* **9.14**);
q) Voltage test on completed cable (*see* **9.15**);
r) Conductor resistance test on completed cable (*see* **9.16**); and
s) Physical properties of insulation and sheath (*see* **9.17**).

9.1.1.1 The type tests shall be made on separate specimens from a sample selected from each of the following groups of cables, a sample being regarded as representative of all of the sizes of cables in its group, provided that they are made by the same process and with the same materials, within the group from which it is selected:

Pren Cables	Group 1	Unipren 4A to 12A
	Group 2	Unipren 18A to 100A
	Group 3	Unipren 135A to 280A
	Group 4	Uniflexpren 6A
	Group 5	Tripren 4A to 9A
	Group 6	Tripren 12A to 24A
	Group 7	Quinpren 6A and Septoprenlarge 6A
Prenal Cables	Group 1	Uniprenal 35A to 100A
	Group 2	Uniprenal 135A to 200A
Prenmet Cables	Group 1	Uniprenmet 4A to 12A
	Group 2	Uniprenmet 18A to 50A
	Group 3	Triprenmet 4A to 24A
	Group 4	Quinprenmet 6A and Septoprenmetlarge 6A
Prensheath Cables	Group 1	Duprensheath 6A, Duprensheathround 6A and Triprensheath 6A
	Group 2	Quinprensheath 6A to Nonoprensheath 6A

9.1.2 *Acceptance Tests* — The following shall constitute acceptance tests:

a) Construction (*see* **9.2**);
b) Identification, packing and marking (*see* **9.3**);
c) Mechanical strength of conductors (*see* **9.4**);
d) Non-inflammability test (*see* **9.5**);
e) Tinning test (*see* **9.6**);
f) Voltage test on core (*see* **9.12**);
g) Insulation resistance test on core (*see* **9.13**);
h) Spark test on core (*see* **9.14**);
j) Voltage test on completed cable (*see* **9.15**);
k) Conductor resistance test on completed cable (*see* **9.16**); and
m) Physical properties of insulation and sheath (*see* **9.17**).

9.1.2.1 The acceptance tests shall be made on each batch of 100 000 m of cable, or at least once during each month's production, whichever is the less. A batch of cable may consist of different sizes and types but, wherever possible, the sample should be representative of the sizes and types being produced.

9.1.2.2 Two samples of cable shall be selected from the production batch, one sample being of the smallest size produced. Specimens from each of these samples shall be subjected to the tests specified in **9.1.2**. Should either of the samples fail in any one of the tests, the tests shall be repeated on specimens from four further samples selected at random. Should any one of these samples fail, the batch shall be deemed not to comply with this standard.

9.1.3 *Routine Tests* — The following shall constitute routine tests:

a) Construction (*see* **9.2**);
b) Identification, packing and marking (*see* **9.3**);
c) Voltage test on core (*see* **9.12**);
d) Insulation resistance test on core (*see* **9.13**);
e) Spark test on core (*see* **9.14**);
f) Voltage test on completed cable (*see* **9.15**);
g) Conductor resistance test on completed cable (*see* **9.16**); and
h) Physical properties of insulation and sheath (*see* **9.17**).

9.1.3.1 The routine tests shall be carried out on every length of cable.

9.2 Construction — All cables shall be checked for compliance with the requirements of this standard relating to construction and dimensions. All completed cables shall be examined along the entire length for defective workmanship.

9.3 Identification, Packing and Marking — Each coil, reel or drum of completed cable shall satisfy the requirements of 7 and 8.

9.4 Mechanical Strength of Conductors

9.4.1 *Conductors from Cables Other than Uniflexpren Type* — The tensile strength of each copper or aluminium wire taken from the finished cable, and the minimum elongation of each copper wire taken from the finished cable shall conform to the values given in Table 9. For these tests the gauge length on the test specimen shall be 25 cm and the clamps shall be separated at a rate not exceeding 13 cm per minute. The tensile strength shall be calculated on the original cross-sectional area of the wire.

9.4.1.1 Aluminium wires shall not break when subjected to the following test:

> Wrap the wire round a wire of its own diameter to form a close helix of eight turns. Unwrap six turns and again closely rewrap them in the same direction as the first wrapping.

9.4.2 *Conductors from Uniflexpren Cable* — The insulation shall be removed carefully from a 30 cm length of uniflexpren cable and the conductor as a whole shall be subjected to a tensile test to determine its breaking load, care being taken to avoid local concentrations of stress at any clamps. If this load is 135 N or less, the conductor shall be regarded as satisfactory; if the load is more than 145 N the conductor shall be regarded as not meeting the requirements of this specification. If the load is more than 135 N but not more than 145 N the diameter of the individual wires of the braid forming the conductor shall be measured. If the apparent breaking stress in the conductor (breaking load divided by 48 times the average measured area of each of the conductor wires) is not more than 253 MPa the conductor shall be regarded as satisfactory.

9.5 Non-Inflammability Test — The number of specimens to be tested shall be as specified in Table 10. All specimens shall be cut consecutively from the same coil.

Each specimen of cable shall be supported at an angle of 45° in a draught-free chamber, and the hottest point of a vertical 75 mm non-luminous flame (9·5 mm Bunsen burner) with a blue cone 25 mm high shall be arranged to impinge on the central portion of the specimen for the time specified in Table 10. After the source of the flame has been removed, the

cable shall meet the following requirements:

a) The cable shall cease to burn within ten seconds, and

b) The total length burned or charred shall not exceed 75 mm.

9.6 Tinning Test — The tinning of copper conductors shall be tested for compliance with the requirements of IS : 8130-1976* as far as applicable.

9.7 Resistance to Fluids — The test specimen shall be bent into a single loop, the internal diameter of which is six times the maximum specified diameter of the complete cable. The specimen shall be immersed in the fluids listed in Table 9 and maintained at the stated temperature for not less than 24 hours, with the cable ends out of the liquid.

At the conclusion of this period the cable shall be removed from the fluid and shall be wound on a mandrel, the diameter of which is three times the maximum specified diameter of the complete cable. The specimen shall be kept on the mandrel for one minute and then unwound. The cable shall show no signs, to normal vision, of splitting or cracking, and the change in diameter shall not exceed the value given in Table 11. During, and at the conclusion of the test, the colour of the cable shall not be appreciably affected.

9.8 Ageing in Air — A specimen, at least 150 mm long, shall be placed in an air oven, maintained continuously at 100 $\pm$ 2°C for seven days. At the conclusion of this ageing period, the sample shall be removed from the oven and kept for fifteen minutes at a temperature of 20 $\pm$ 5°C. The specimen shall then be wound on a mandrel, the diameter of which is four times the maximum specified dimension of the complete cable. After one minute on the mandrel the specimen shall be unwound and it shall show no undue deterioration.

9.9 Low Temperature Test — A specimen of the cable, at least 30 cm long, shall be stored in air at -30 ± 2°C for a period of six hours, immediately after which it shall be wound on mandrel, the diameter of which is ten times the maximum specified diameter of the cable. The rate of winding shall be approximately one revolution per second. After one minute on the mandrel, the cable shall not show, to a normal vision, any signs of cracking.

9.9.1 Multi-core pren and multi-core prenmet cables shall be tested at a temperature of -15 ± 2°C.

NOTE 1 — The mandrels shall be of metal and shall be allowed to cool to the specified temperature with the cable.

NOTE 2 — Cables fulfilling the requirements of this test will withstand a temperature of —75°C when installed in aircraft and not subject to movement.

*Specification for conductors for insulated electric cables and flexible cords.

9.10 Flexibility — A specimen of the complete cable shall be wound on a mandrel at room temperature, under a tensile load of 22·5 N for cables up to and including 12·7 mm in diameter, or 45 N for cables over 12·7 mm in diameter, into a close helix, the internal diameter of which is three times the maximum specified diameter of the cable. The complete test shall comprise five test cycles, each cycle consisting of the winding of the cable on to the mandrel, unwinding and re-winding in the reverse direction, so that the surface of the cable on the inside of the helix during the first winding is on the outside of the helix upon re-winding. No part of the cable shall show signs of damage after the test.

9.11 Voltage Test — At the conclusion of each of the tests specified in **9.7**, **9.8**, **9.9** and **9.10** each specimen shall be immersed in water and, whilst so immersed, shall withstand a test voltage of 1 500 V rms (as specified in **9.12**) maintained for one minute, applied between the conductor and the water. For multi-core cables this test shall be made on core taken from the complete cable.

9.12 Voltage Test on Core — Except when tested in accordance with **9.14** all cores shall be immersed in water at room temperature for not less than 12 consecutive hours; at the end of that time whilst so immersed it shall withstand the voltage shown in Table 12 applied between the conductor and water. The voltage shall be applied gradually and maintained continuously for fifteen minutes. The regulation of the supply for the voltage test shall be such as to maintain the specified voltage on the cable throughout the test. The peak value of the voltage wave shall be within $\pm$ 5 percent of $\sqrt{2} \times$ rms value and the frequency shall be at any value from 25 to 100 Hz.

9.13 Insulation Resistance Test on Core — After the application of the voltage test and whilst the core is still immersed, the insulation resistance for 1 000 m measured between the conductor and water after one minute's electrification with the voltage shown in Table 12, when corrected to a temperature of 20°C shall be not less than the value stated in Table 12. The rate of change of apparent insulation resistance during the one minute's electrification shall be steady.

9.14 Spark Test on Core — A spark test in accordance with IS : 9968 (Part I)-1981* on all dry cores and a voltage and insulation resistance test on 5 percent of all the cores may be made instead of a voltage and insulation resistance test on all cores. The spark test voltage shall be in accordance with Table 12 and the voltage and insulation resistance test in accordance with **9.12** and **9.13**.

*Specification for elastomer insulated cables: Part I For working voltages up to and including 1 100 volts.

9.15 Voltage Test on Completed Cable

9.15.1 *Multi-Core Types Other than Metal Braided* — All completed cables shall withstand 3 000 V rms applied for one minute between each conductor and the remainder connected together. The cable shall be tested in a dry state and the voltage supply shall be as specified in **9.12**.

9.15.2 *Metal Braided Cables* — Multi-core cables, before metal braiding, shall be tested in accordance with **9.15.1**. After braiding, all cables, including single-core cables, shall withstand 1 500 V rms applied for one minute between all the conductors connected together and the metal braid.

9.16 Conductor Resistance Test on Completed Cable — The conductor resistance shall be measured on all completed cable and the resistance of a single conductor per 1 000 m of the finished cable shall not exceed the value stated in Tables 1 and 2 (for copper and aluminium respectively) at the specified temperature.

The resistance of multi-core cables in completed form shall not exceed the value specified for the corresponding size of single core cable by more than 5 percent.

9.17 Physical Properties of Insulation and Sheath — The insulation and sheath shall be tested for compliance with the properties listed in Table 13.

TABLE 1 DETAILS OF UNIPREN CABLES

[*Clauses* 5.0.1.1, 5.0.2, 5.0.2.2, 9.16, A-1.1(a) *and* Table 7]

Cable Designation	Conductor			Diameter		Minimum Permissible Thickness of Polychloropren Compound	Overall Diameter of Finished Cable		Maximum Conductor Resistance for 1 000 Metres at 20°C	Nominal Mass per 100 m (for Reference only)
	Nominal Area	No. of Wires	Nominal Diameter of Wires	*Max*	*Min*		*Max*	*Min*		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Unipren	sq mm		mm	mm	mm	mm	mm	mm	Ohm	kg/100 m
4	0·336	19	0·15	0·80	0·70	0·51	2·65	2·40	60·00	1·2
6	0·596	19	0·20	1·05	0·95	0·51	2·80	2·55	33·40	1·3
9	0·931	19	0·25	1·30	1·20	0·51	2·90	2·65	21·20	1·8
12	1·34	19	0·30	1·55	1·45	0·51	3·30	2·90	14·70	2·1
18	1·82	37	0·25	1·82	1·70	0·51	3·80	3·40	10·90	3·0
24	2·88	37	0·315	2·30	2·10	0·51	4·30	3·90	6·73	4·5
35	4·65	37	0·40	2·90	2·70	0·64	5·10	4·70	4·13	7·5
50	8·42	119 (7 × 17)	0·30	4·10	3·80	0·64	6·50	6·00	2·40	10·5

70	12·9	182 (7 × 26)	0·30	5·30	4·85	0·76	7·85	7·35	1·57	16·5
100	20·8	294 (7 × 42)	0·30	6·65	6·20	0·76	9·40	8·90	0·971	27·0
135	32·4	203 (7 × 29)	0·45	8·40	7·80	0·76	11·30	10·80	0·606	38·5
150	39·4	247 (19 × 13)	0·45	9·45	8·85	0·89	12·55	11·95	0·500	46·0
170	51·5	323 (19 × 17)	0·45	10·55	9·95	0·89	13·95	13·35	0·381	58·0
200	66·8	418 (19 × 22)	0·45	11·95	11·25	0·89	15·50	14·75	0·280	74·5
230	82·0	513 (19 × 27)	0·45	13·05	12·35	1·02	17·25	16·50	0·237	92·0
280	107·0	666 (37 × 18)	0·45	15·10	14·30	1·02	19·05	18·30	0·190	116·0
Uniflex-pren 6	0·556	48 (16 × 3 Braided)	0·122	1·15	0·95	0·51	2·80	2·55	37	1·5

TABLE 2 DETAILS OF PRENAL CABLES

(*Clauses* 5.0.1.1, 5.0.2, 5.0.2.2, 9.16 *and* A-2.1)

Cable Designation	Conductor			Diameter of Conductor		Minimum Permissible Thickness of Polychloroprene Compound	Overall Diameter of Finished Cable		Maximum Conductor Resistance for 1 000 m at 20°C	Nominal Mass per 100 m (for Reference only)
	*Nominal Conductor Area	No. of Wires	Nominal Diameter of Wires	*Max*	*Min*		*Max*	*Min*		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Uniprenal	sq mm		mm	mm	mm	mm	mm	mm	Ohm	kg/100 m
35	8·31	41	0·508	4·7	3·81	0·64	6·48	5·97	3·64	5·95
50	14·2	70 (7 × 10)	0·508	5·35	5·05	0·76	7·87	7·37	2·13	8·93
70	21·3	105 (7 × 15)	0·508	6·66	6·27	0·76	9·27	8·76	1·42	11·91
100	34·1	168 (7 × 24)	0·508	8·40	7·87	0·76	11·05	10·54	0·895	17·86
135	53·9	266 (19 × 14)	0·508	10·35	10·10	0·89	13·59	12·95	0·565	25·30
150	69·3	342 (19 × 18)	0·508	12·15	11·50	0·89	15·24	14·48	0·443	29·80
170	84·7	418 (19 × 22)	0·508	13·60	12·95	1·02	17·02	16·26	0·363	40·20
200	108·0	532 (19 × 28)	0·508	14·90	14·25	1·02	18·29	17·53	0·283	46·10

*Calculated on the basis of the Formula $\frac{n \pi d_2}{4}$

where d = nominal diameter of each individual wire in mm, and
n = number of individual wires in conductor.

TABLE 3 COLOUR SCHEME FOR MULTI-CORE CABLES

[*Clauses* 5.2, 5.5.3, 6.5 *and* A-1.1(b)]

No. of Cores	Colour of Polychloroprene Compound
2	Red and blue
3	Red, blue and yellow
5	Red, blue, yellow, green and white
6	Red, blue yellow, green, white and black
7	Red, blue, yellow, green, white, black and brown
9	Red, blue, yellow, green, white, black, brown orange and violet

TABLE 4 DETAILS OF TRIPREN, QUINPREN AND SEPTOPREN LARGE CABLES

(*Clause* 5.2.3)

Current Rating	Overall Dimensions of Finished Cable								
	Tripren			Quinpren			Septopren Large		
	Max	*Min*	Nominal mass (for reference only)	*Max*	*Min*	Nominal mass (for reference only)	*Max*	*Min*	Nominal mass (for reference only)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Amps	mm	mm	kg/100 m	mm	mm	kg/100 m	mm	mm	kg/100 m
4	6·50	5·35	5·2						
6	6·75	5·60	5·8	8·25	7·00	10·4	9·55	8·25	11·9
9	7·00	5·85	6·6						
12	7·75	6·35	8·9						
18	8·90	7·50	11·9						
24	10·05	8.50	17·9						

TABLE 5 DETAILS OF UNIPRENMET CABLES

(*Clauses* 5.4.5 *and* A-3.1)

Current Rating	Overall Diameter of Cables		Dia of Braiding Wire	Nominal Mass (for Reference only)
	Max	*Min*		
(1)	(2)	(3)	(4)	(5)
A	mm	mm	mm	kg/100 m
4	3·30	2·90	0·122	2·2
6	3·45	3·05	0·122	2·4
9	3·55	3·15	0·122	3·0
12	4·30	3·70	0·20	4·5
18	4·80	4·20	0·20	6·0
24	5·35	4·70	0·20	7·4
35	6·10	5·45	0·20	10·4
50	7·50	6·75	0·20	16·4

TABLE 6 DETAILS OF TRIPRENMET, QUINPRENMET AND SEPTOPRENMET LARGE CABLES

(*Clauses* 5.4.5 *and* A-3.1)

Current Rating	Overall Diameter of Finished Cable									Diameter of Braiding Wire
	Triprenmet			Quinprenmet			Septoprenmet Large			
	Max	*Min*	Nominal mass (for reference only)	*Max*	*Min*	Nominal mass (for reference only)	*Max*	*Min*	Nominal mass (for reference only)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
A	mm	mm	kg/100 m	mm	mm	kg/100 m	mm	mm	kg/100 m	mm
4	7·25	6·10	8·9							0·20
6	7·50	6·35	10·4	9·00	7·75	14·9	10·30	9·00	19·30	0·20
9	7·75	6·60	11·9							0·20
12	8·50	7·10	13·4							0·20
18	9·65	8·25	17·9							0·20
24	10·80	9·25	22·3							0·20

TABLE 7 DETAILS OF PRENSHEATH CABLES

(*Clauses* 5.5, 5.5.2 *and* A-4.1)

Cable Designation	Minimum Radial Thickness of Sheath	Overall Dimensions of Finished Cable*		Nominal Mass (for Reference only)
		Max	*Min*	
(1)	(2)	(3)	(4)	(5)
	mm	mm	mm	kg/100 m
Duprensheath 6	0·76	4·45 × 7·10	3·95 × 6·60	4·9
Duprensheath Round 6	0·76	7·10	6·60	7·4
Triprensheath 6	0·76	7·50	7·00	8·9
Quinprensheath 6	0·76	9·00	8·50	11·0
Sextoprensheath Large 6	0·76	9·80	9·25	14·9
Septoppensheath Large 6	0·76	11·05	10·05	17·9
Nonopren sheath 6	0·76	12·55	11·70	23·8

*In order to obtain these dimensions it may be necessary to select unipren 6 cables, which are below the maximum dimensions given in Table 1.

TABLE 8 COLOURS OF CELLULOSE ACETATE MARKER THREAD FOR IDENTIFICATION OF YEAR OF MANUFACTURE

(*Clause* 7.2)

Date of Manufacture	Colour of Marker Thread
1978	Yellow/blue
1979	Yellow/green
1980	Yellow/black
1981	Yellow/white
1982	Yellow/red
1983	Blue/brown
1984	Blue/green
1985	Blue/black
1986	Blue/white
1987	Blue/red

Note — As cellulose acetate marker thread soluble in acetone is not available indigenously, cotton marker thread insoluble in acetone can be used as an alternate.

TABLE 9 TENSILE TESTS ON CONDUCTORS

(*Clause* 9.4.1)

Material	Diameter	Tensile Strength	Minimum Elongation
(1)	(2)	(3)	(4)
	mm	N/mm^2	Percent
Copper	0·508 to 0·305	302·3 (*Max*)	13·5
	0·279 to 0·076	309·35 (*Max*)	9
Aluminium	0·508	127·0 (*Min*) 169·0 (*Max*)	—

TABLE 10 NON-INFLAMMABILITY TEST

(*Clause* 9.5)

Cable Designation	Time of Flame Application	Specimens Tested
Unipren 4 to 9, Uniflexpren 6 and Uniprenmet 4 to 9	5 seconds	10
Unipren 12 to 280, tripren 4 to 24, Quinpren 6, Septoprenlarge 6, all Prenal, Uniprenmet 12 to 50, Triprenmet 4 to 24, Quinprenmet 6, Septoprenmetlarge 6, and all Prensheath	15 seconds	1

TABLE 11 RESISTANCE TO FLUIDS

(*Clause* 9.7)

Fluid Represented	Test Fluid	Temperature of Test	Maximum Change in Diameter
(1)	(2)	(3)	(4)
		°C	Percent
Fuel	70 percent iso-octane, 30 percent toluene, by volume	20 ± 5	20
Hydraulic fluid	80 percent ethylene glycol monoethyl ether + 20 percent castor oil by volume	50 ± 2	5

TABLE 12 ELECTRICAL TESTS ON CORES

(*Clauses* 9.12 *and* 9.13)

Voltage Test Volts (rms)	Insulation Resistance		Equivalent Spark Test Kilovolts (rms)
	Test Voltage (dc)	Minimum Resistance for 1 000 m megohms	
1 500	500	1·0	6 up to and including unipren 135 and uniprenal 100
			8 above unipren 135 and uniprenal 100

TABLE 13 PHYSICAL PROPERTIES OF POLYCHLOROPRENE COMPOUND INSULATION AND SHEATH

(*Clause* 9.17)

Tensile strength N/mm^2 (*Min*)	..	..	..	6·328
Elongation at break, percent, *Min*	..	..	..	400
Tension set on stretching from 51 to 127 mm for 4 hours with 2 hours recovery : Percent *Max*	..	..	..	30
Ageing—After ageing for 120 hours in air at 100°C tensile strength shall not decrease from the unaged value by more than	..	..	..	40 percent
Elongation at break after ageing, percent, *Min*	..	..	..	250

APPENDIX A

(*Clause* 3.1)

NOMENCLATURE

A-1. PREN CABLES

A-1.1 (a) Single Core (Table 1)

Unipren	*Unipren*
4	70
6	100
9	135
12	150
18	170
24	200
35	230
50	280

Uniflexpren
6

(b) Multi-Core (Table 3)

Tripren
4
6
9
12
18
24

Quinpren
6

Septoprenlarge
6

A-2. PRENAL CABLES

A-2.1 Single Core (Table 2)

Uniprenal	*Uniprenal*
35	135
50	150
70	170
100	200

A-3. PRENMET CABLES

A-3.1 Prennet Cables (Tables 5 & 6)

Uniprenmet	*Triprenmet*
4	4
6	6
9	9
12	12
18	18
24	24
	Quinprenmet
35	6
	Septoprenmetlarge
50	6

A-4. PRENSHEATH CABLES

A-4.1 Prensheath Cables (Table 7)

Duprensheath
6

Duprensheathround
6

Triprensheath
6

Quinprensheath
6

Sextoprensheath
6

Septoprensheathlarge
6

Nonoprensheath
6

APPENDIX B

(*Clause* 5.4.5)

METAL BRAIDING DETAILS

B-1. FORMULAE TO BE USED IN CALCULATING DETAILS OF OVERALL METAL BRAID FILLING FACTOR

a) The filling factor K is defined as:

$$\frac{m.n.d_w.}{2\pi D}\left(1+\frac{\pi^2 D^2}{L^2}\right)^{\frac{1}{2}}$$

b) The lay factor KL is defined as:

$$K = 1+\frac{\pi^2 D^2}{L^2}$$

where

D = mean diameter of braid (mm),
d_w = diameter of baiding wire (mm),
L = lay of braiding wire (mm),
m = total number of spindles, and
n = total number of ends per spindle.